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CLAIMS

1. An optical code reading apparatus, comprising:

- a casing;

- a reading window open into the casing;

- an illuminating means (3), housed within the casing, and arranged to act on an optical code to be read through the reading window;

- a detection means (4), housed within the casing and responsive to light scattered from the illuminated optical code into the casing through the reading window;

- an objective lens (9) having an optical axis (Z), the objective lens being housed within the casing between the reading window and the detection means (4), and being located to pick up light scattered from the illuminated optical code and project the picked-up light onto the detection means (4), wherein the detection means (4) comprises a plurality of light-sensitive elements (5a) capable of converting said light to electric signals representing the light image;

characterized in that the illuminating means (3) comprises a first array of light sources (6) which are active in a first illumination configuration, and at least a second array of light sources (7) which are active in at least a second illumination configuration different from the first.

2. An apparatus according to Claim 1, wherein the first array of light sources (6) comprises a plurality of light source pairs (61,62), each pair (61,62) in turn comprising respective light sources symmetrically arranged with respect to the optical axis (Z) of the objective lens (9) and aligned along a substantially perpendicular direction to said optical axis (Z), said light sources lying in a first emission lay (X-Z) intersecting the optical axis (Z) and the light-sensitive elements (5a) of the detection

means (4).

3. An apparatus according to Claim 2, wherein the plurality of light source pairs (61,62) comprises a pair of outward sources (61) disposed in an offset position from the optical axis (Z) of the objective lens (9) by an angle α, and a pair of inward sources (62) disposed in an offset position from the optical axis (Z) of the objective lens (9) by an angle β, smaller than the angle α.

4. An apparatus according to Claim 3, wherein the angle α is in the range of about 15° to about 18°, and the angle β is in the range of about 3° to about 6°.

5. An apparatus according to Claim 1, wherein the detection means (4) comprises a linear CCD sensor (5).

6. An apparatus according to Claim 1, wherein the detection means (4) comprises a CCD matrix sensor.

7. An apparatus according to Claim 1, wherein the detection means (4) comprises a CMOS sensor.

8. An apparatus according to Claim 1, further comprising a means (10,11) for confining the light beam from the first array of light sources (6) within a predetermined reading area.

9. An apparatus according to ~~Claims 3 and 8~~ Claim 8, wherein the means (10,11) for confining the light beam from the first array of light sources comprises a ring-shaped masking element (11) associated with the casing at the location of the reading window and having a substantially straight inward edge (12), set at an angle substantially equal to $\alpha$with respect to the optical axis (Z) of the objective lens (9).

10. An apparatus according to ~~Claims 2 and 8~~ Claim 2, further comprising a holder element(8) for the plurality of light source pairs (61,62) which is formed with respective seats

(6a) for said light sources, said seats (6a) having respective side walls (10) shaped to confine the light beam from each source within the predetermined reading area.

11. An apparatus according to Claim 2, further comprising a means for widening the emission angle of the light beam from the first array of light sources (6) along the direction of alignment of said first array of light sources, and narrowing the emission angle of the light beam from the first array of light sources (6) along the perpendicular direction to the first emission lay (X-Z).

12. An apparatus according to Claim 11, wherein the means for widening the emission angle of the light beam from the first array of light sources (6) along the direction of alignment of said first array of light sources and narrowing it along the perpendicular direction to the first emission lay (X-Z) comprises a pair of converging lenses (13) housed within the casing at symmetrical locations with respect to the optical axis (Z) of the objective lens (9), between the first array of light sources (6) and the reading window.

13. An apparatus according to Claim 1, wherein the second array of light sources (7) comprises a plurality of second light sources having a lower light intensity than the sources in the first array of light sources (6).

14. An apparatus according to ~~Claims 2 and 13~~ Claim 2, wherein the second light sources are housed within the casing symmetrically with respect to the optical axis (Z) of the objective lens (9), so as to be aligned to one another in a second emission lay, different from the first one.

15. An apparatus according to Claim 14, wherein the second light sources are housed within the casing centrally with respect to the first array of light sources (6), and wherein the second emission lay is lower than the first emission lay (X-Z).

16. An apparatus according to Claim 1, wherein the first array of light sources (6) comprises two pairs of discrete plastics LEDs and the second array of light sources (7) comprises four SMD plastics LEDs.

17. An apparatus according to Claim 1, respectively comprising a means for measuring the distance of the optical code to be read from the reading apparatus, and a means for activating said first and at least second arrays of light sources (6,7) according to the distance measured.

18. An apparatus according to Claim 1, respectively comprising a means for detecting the light intensity outline of the light scattered from the optical code, a means for comparing this outline with a reference outline , and a means for activating said first and at least second arrays of light sources (6,7) according to the difference between the detected outline and the reference outline .

19. An apparatus according to Claim 1 ~~any of the preceding claims~~, further comprising a means for decoding the optical code.

20. An apparatus according to Claim 19, further comprising a means for activating said first and at least second arrays of light sources (6,7) according to the results of decoding attempts.

21. An apparatus according to Claim 20, wherein the means for activating said first and at least second arrays of light sources (6,7) comprises a microprocessor, the apparatus further including a means of amplifying the electric signals generated by the detection means and means of converting the amplified electric signals to digital signals to be delivered to the microprocessor.

22. An apparatus according to Claim 21, further comprising a means for varying the amplification level of the electric signals generated by the detection means.

23. An apparatus according to Claim 21, wherein the

converting means comprises a main digitalizer having a preset sensitivity, and an auxiliary digitalizer whose sensitivity is higher than that of the main digitalizer.

24. A method of reading an optical code by an apparatus comprising a means of illuminating an optical code to be read and means of detecting light scattered from the illuminated optical code, which method comprises the following steps:

- a) illuminating an optical code to be read so as to define a read scan;

- b) picking up the light scattered from the illuminated optical code on the detection means;

- c) converting the picked-up light to electric signals representing the light image;

characterized in that step a) of illuminating the optical code in turn comprises the following steps:

- a1) acquiring an operational parameter indicating specific conditions of the reading operation;

- a2) activating, according to the acquired operational parameter, a first array and/or at least a second array of light sources so as to illuminate the code according to respective preset illumination configurations.

25. A method according to Claim 24, wherein said first array of light sources comprise a plurality of sources having a predetermined light intensity, and said at least a second array of light sources comprises a plurality of sources having a lower light intensity than said sources in the first array.

26. A method according to Claim 24, wherein step a1) of acquiring the operational parameter includes a step of measuring the distance of the code to be read from the reading apparatus.

27. A method according to Claim 24, wherein step a1) of acquiring the operational parameter includes the following steps:

- detecting a light intensity outline of the light scattered from the optical code;

- comparing said outline with a reference outline ;

- controlling the emissions from the light sources in the first and/or second arrays of light sources according to the difference between the detected outline and the reference outline.

28. A method according to Claim 24, further comprising the following steps:

- d) amplifying the electric signals generated by the detection means;

- e) converting the amplified electric signals to digital signals by means of a digitalizer;

- f) carrying out an attempt of decoding the optical code; and

- f1) if said attempt gives a positive result, indicating the decoded code and repeating the steps from a) to read a new code;

- f2) if said attempt gives a negative result, iteratively repeating for a predetermined number i of times the steps from a), while each time changing the illumination configuration.

29. A method according to Claim 28, wherein step f) of carrying out an attempt of decoding the optical code is preceded by the following step:

- e1) examining the digitalized signals to detect the number of transitions contained therein and check if said

number is greater than or equal to a predetermined value K, and:

- e1a) if such check gives a positive result, carrying out step f);

- e1b) if such check gives a negative result, abandoning the scan under examination and iteratively repeating the steps from a) for a predetermined number i of times.

30. A method according to Claim 24, wherein step a) of illuminating the optical code to be read is preceded by the following step:

- i) setting a first configuration mode by activating a main digitalizer having a preset sensitivity and the first array of light sources respectively.

31. A method according to Claim 30, wherein if the check in step e1) gives a negative result consecutively for a predetermined number j of times, the following step is carried out:

- e1b1a) switching to a second configuration mode by activating, rather than the main digitalizer, an auxiliary digitalizer having higher sensitivity than that of the main digitalizer, and iteratively repeating the steps from a), to switch back to the first configuration mode if alternatively:

- a decoding attempt is successful;

- the check in step e1) gives a negative result consecutively for a number j of times;

- a number of unsuccessful decoding attempts is made which is greater than a predetermined number q.

32. A method according to Claim 30, wherein if the check in step e1) gives a negative result consecutively for a

predetermined number j of times and at least one decoding attempt has been unsuccessful, or a number of unsuccessful decoding attempts is made which is greater than a predetermined number p, the following step is carried out:

- e1b1b) switching to a third configuration mode by activating, rather than the main digitalizer, an auxiliary digitalizer having higher sensitivity than that of the main digitalizer, and iteratively repeating the steps from a), to switch back to the first configuration mode if alternatively:

- a decoding attempt is successful;

- the check in step e1) gives a negative result consecutively for a number j of times.

33. A method according to Claim 32, wherein if in step e1b1b) a number of unsuccessful decoding attempts is made which is greater than a predetermined number q, the following step is carried out:

- e1b1b1) switching to a fourth configuration mode by activating the main digitalizer and the second array of light sources and controlling the emission from the sources in the first array of light sources, and iteratively repeating the steps from a), to switch back to the first configuration mode if a decoding attempt is successful.

34. A method according to Claim 33, wherein if in step e1b1b1) a number of unsuccessful decoding attempts is made which is greater than a predetermined number p, or the check in step e1) gives a negative result consecutively for a predetermined number j of times, the following step is carried out:

- e1b1b1a) switching to a fifth configuration mode by activating the auxiliary digitalizer and the second array of light sources and iteratively repeating the steps from a), to switch back to the first configuration mode if

alternatively:

- a decoding attempt is successful;

- the check in step e1) gives a negative result consecutively for a predetermined number j of times;

- a number of unsuccessful decoding attempts is made which is greater than a predetermined number q.

35. A method according to ~~claims 32 to 34~~ Claim 32, further comprising a step of varying the amplification level by suddenly forcing a predetermined maximum value before respectively switching from the third configuration mode to the fourth one, and from the fourth and fifth configuration modes to the first one.